

# POLLUTION PROCESSING BY RADIATION FOGS DURING THE CALIFORNIA REGIONAL PM10/PM2.5 AIR QUALITY STUDY (CRPAQS)

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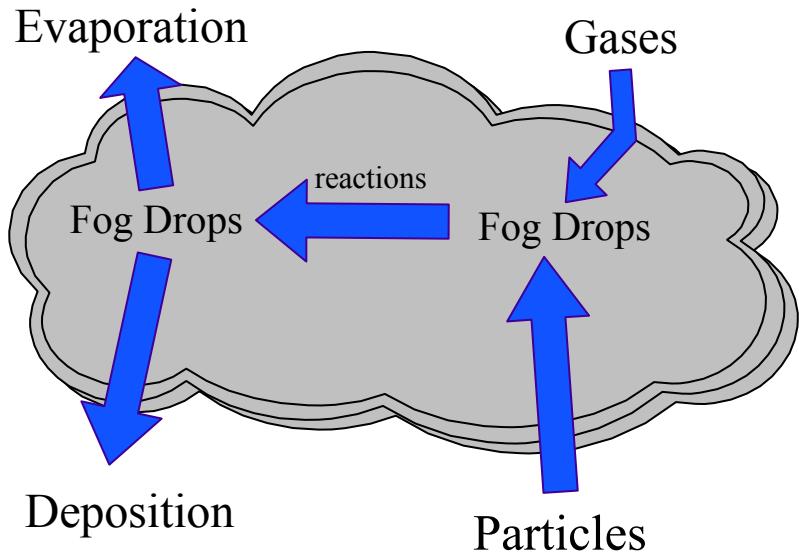
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San Joaquin Valleywide Air Pollution Study Agency and NSF

# SJV fogs

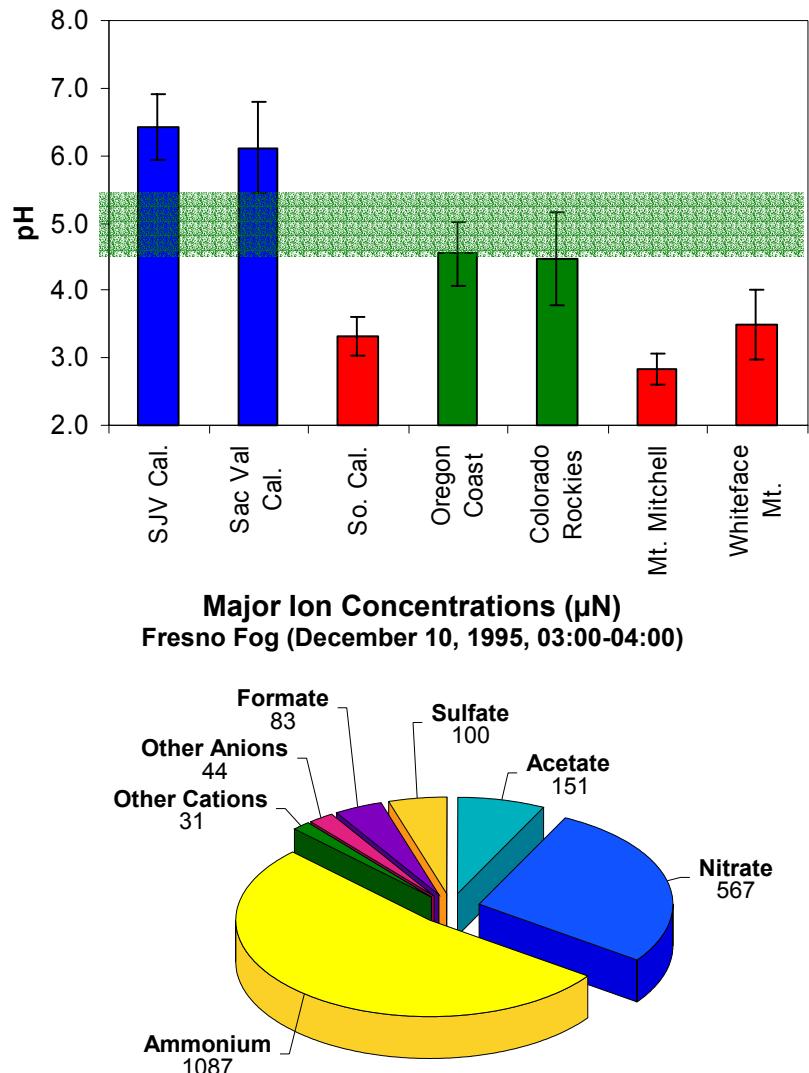


- Dense, widespread radiation fogs occur during winter
  - Moist air trapped in valley by thermal inversion
  - Radiative cooling produces fogs
- Fogs affect particles by
  - Production of non-volatile solute mass
  - scavenging and deposition



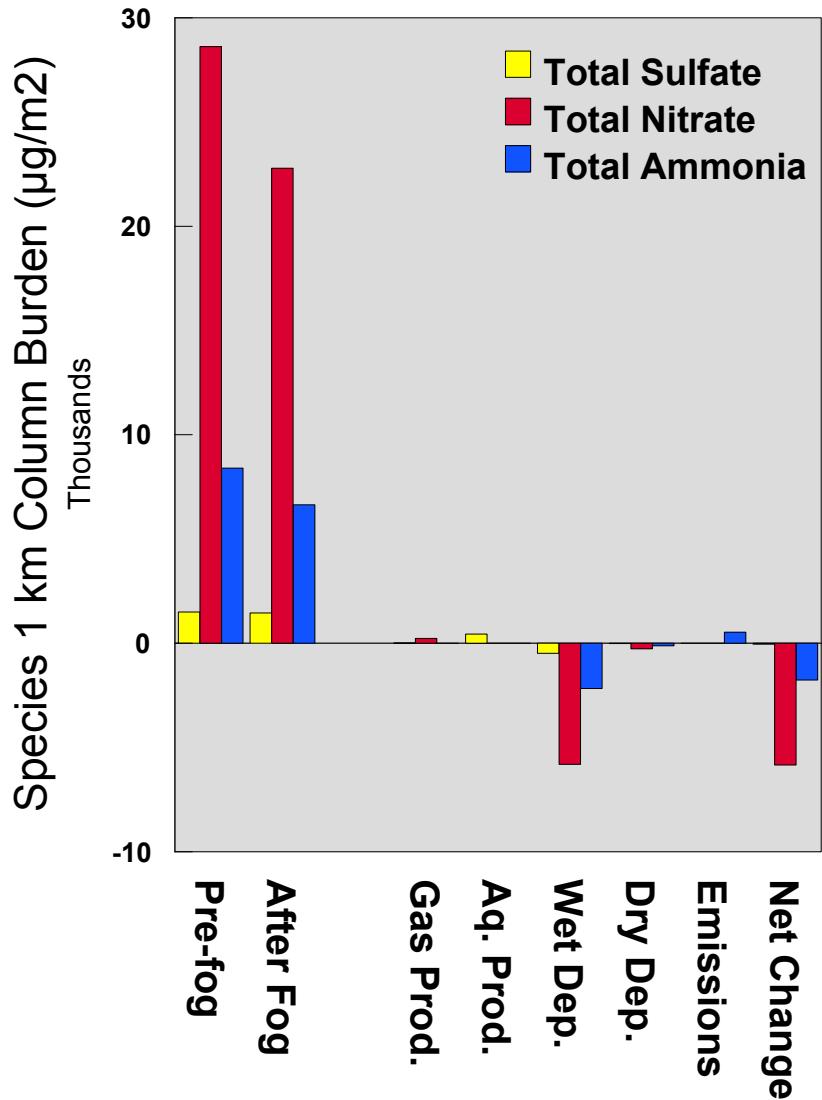
# Past Studies of SJV fogs - I

- Nitrate and ammonium typically major species
  - pH high
  - Important organic carbon contributions
  - Nitrite and sulfate also present
  - Composition variable in time and space



# Past Studies of SJV fogs - II

- Deposition of inorganic ions important
  - sulfate production ~ balances sulfate deposition
- How do fogs process OC ?

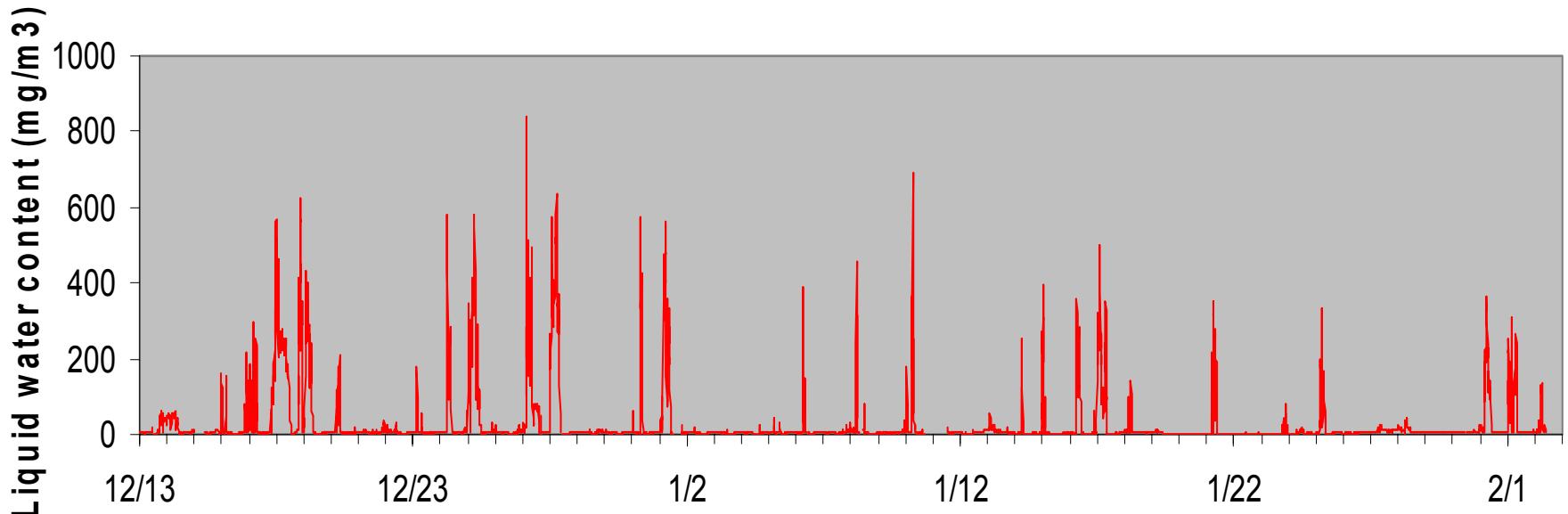
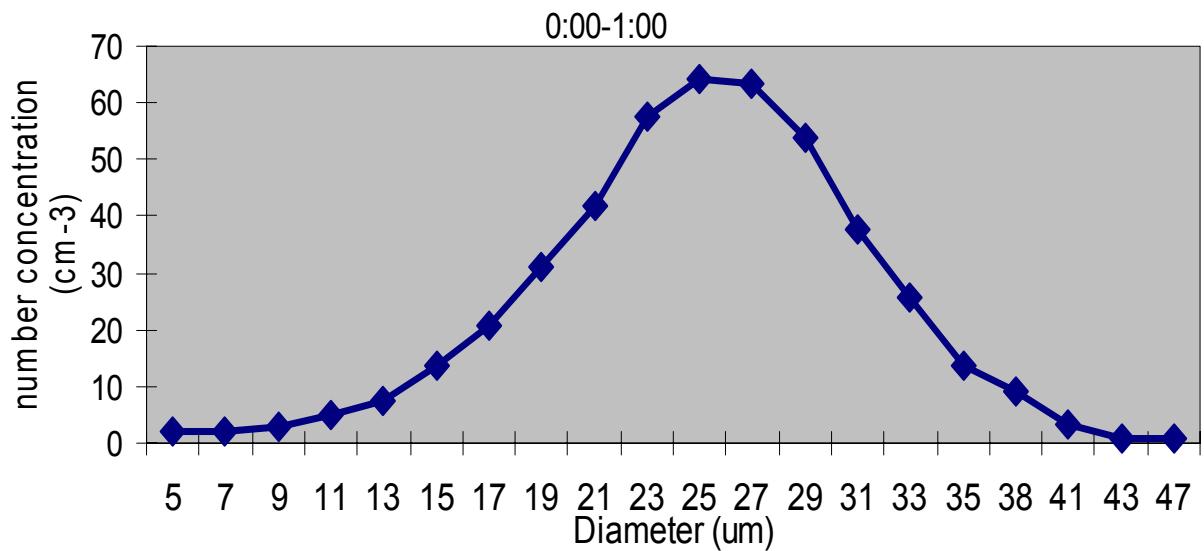


# Fog Measurements



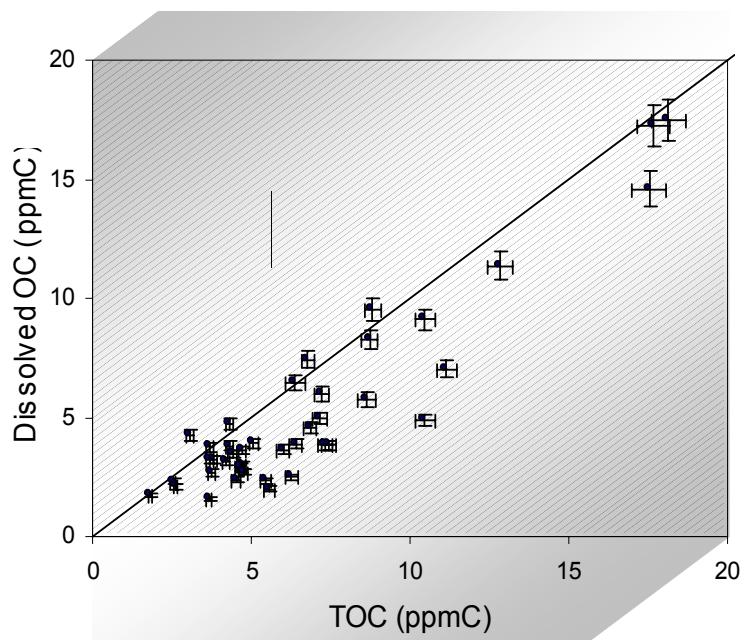
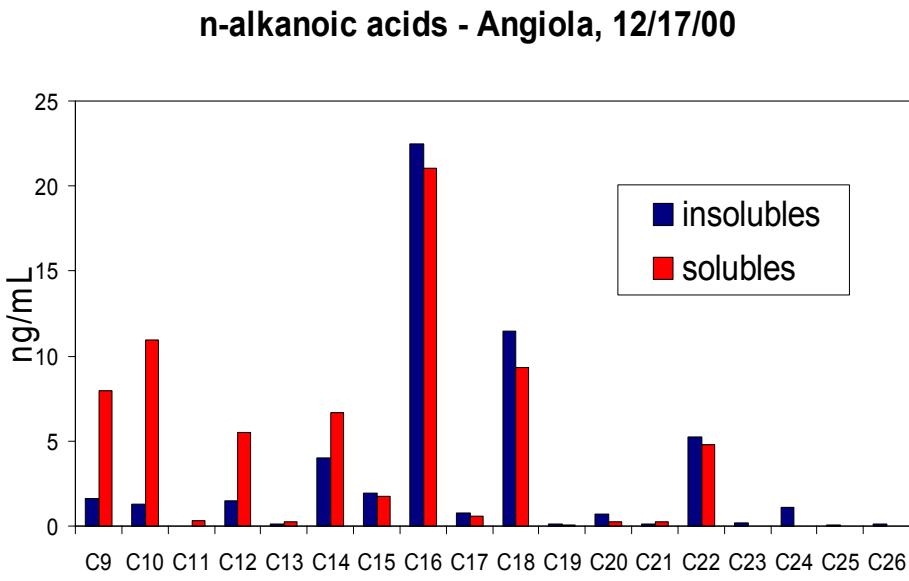
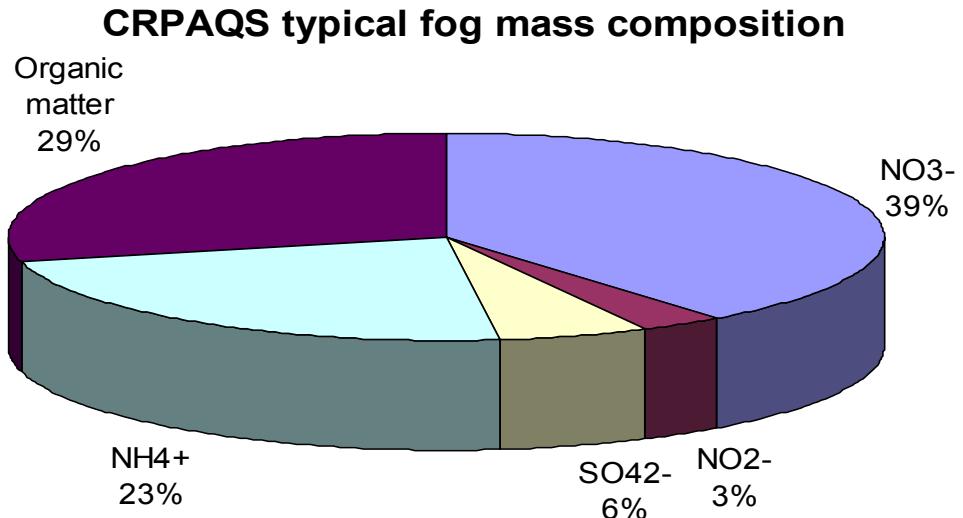
# CRPAQS Fog Episodes

- Several fog episodes
- Shallow fog layer
- Large drops



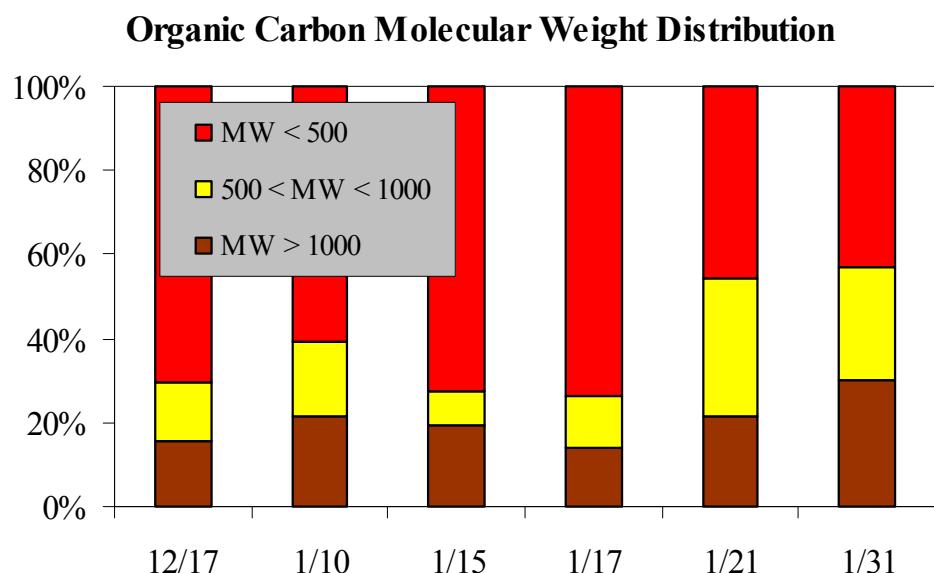
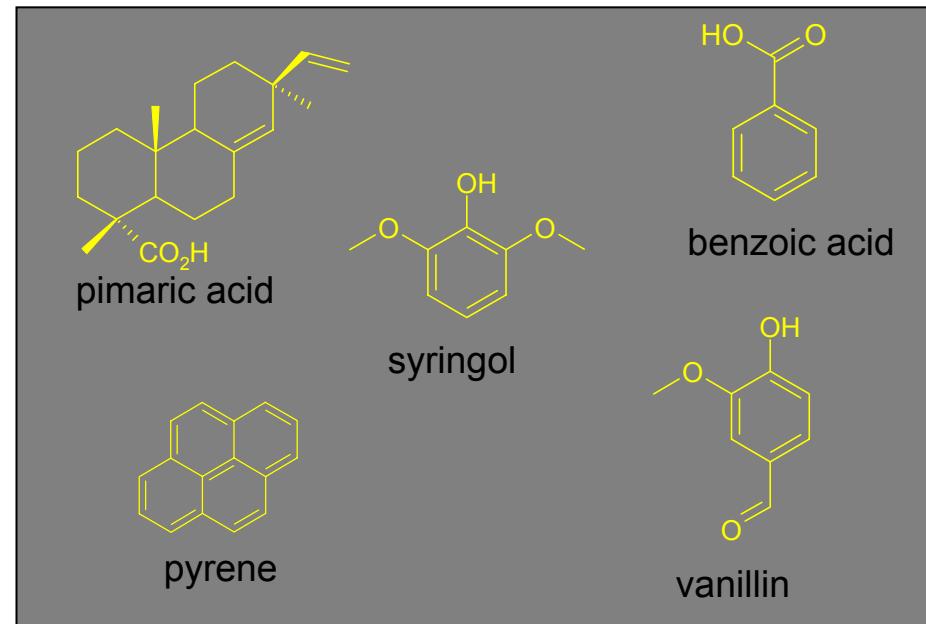
# CRPAQS Fog Organics

- Organic carbon is key component of CRPAQS fogs
- ~75% of OC is dissolved
- Fogs process soluble and insoluble OC

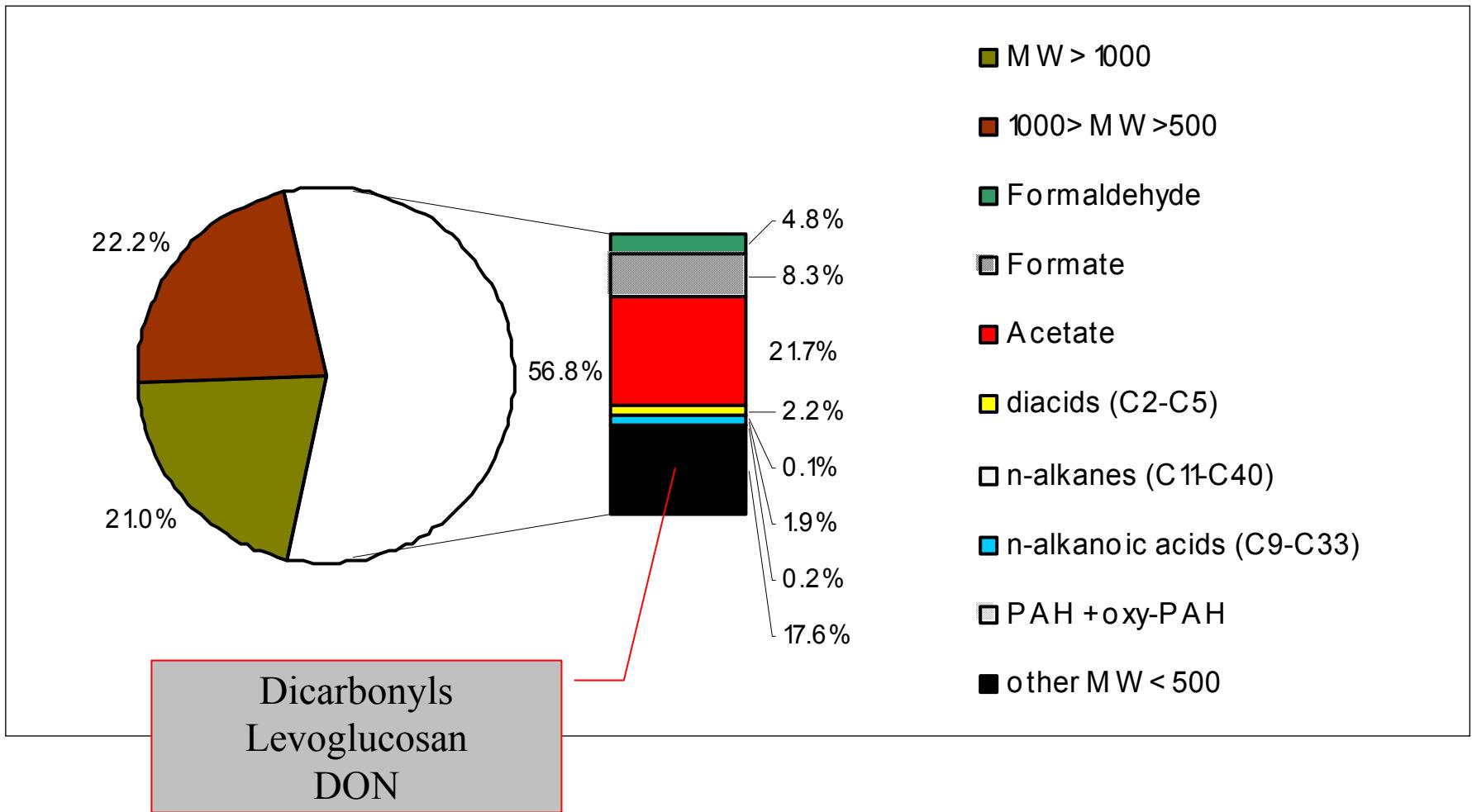


# CRPAQS Fog Organics - II

- Many organic compounds present
  - PM source tracers
- Lots of high molecular weight material

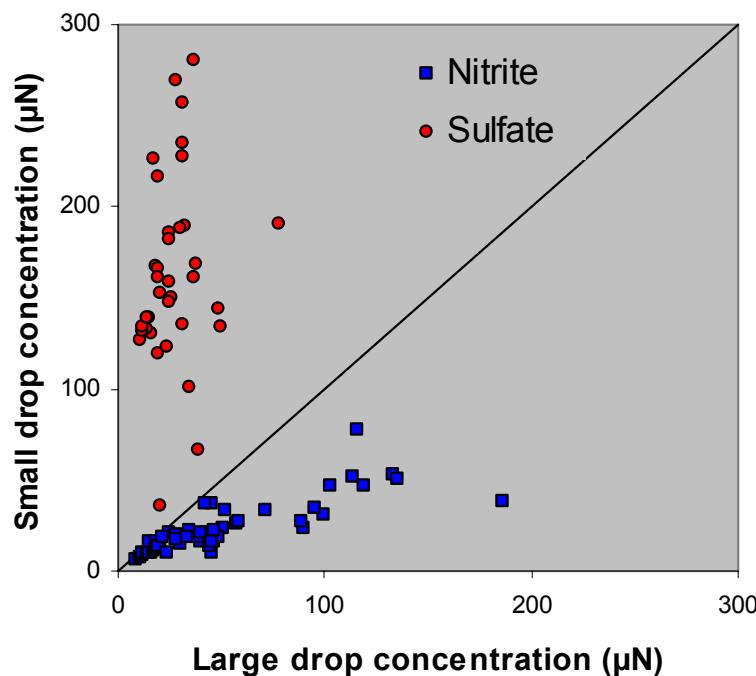
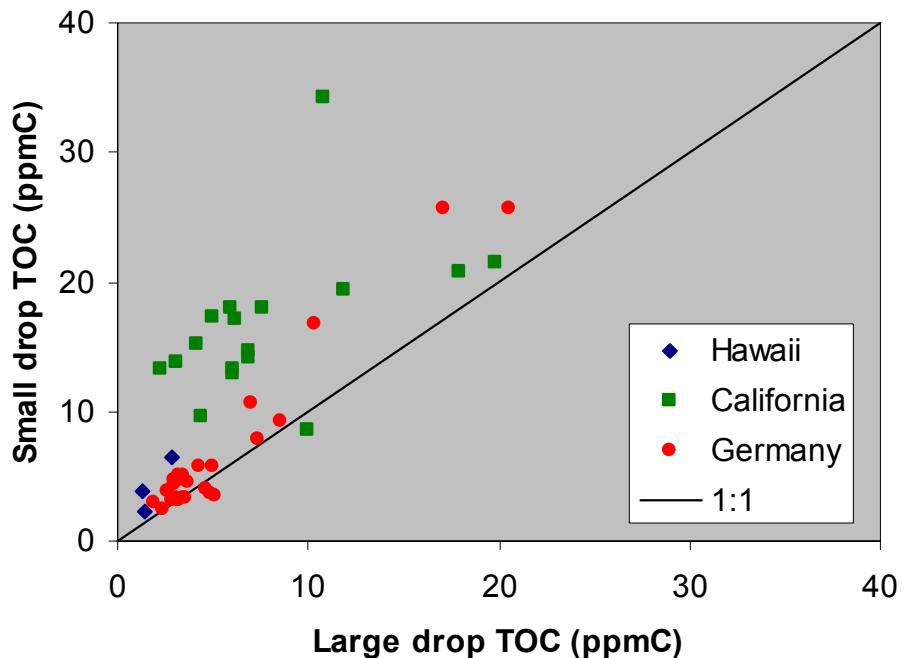


# Fog Dissolved Organic Carbon Composition



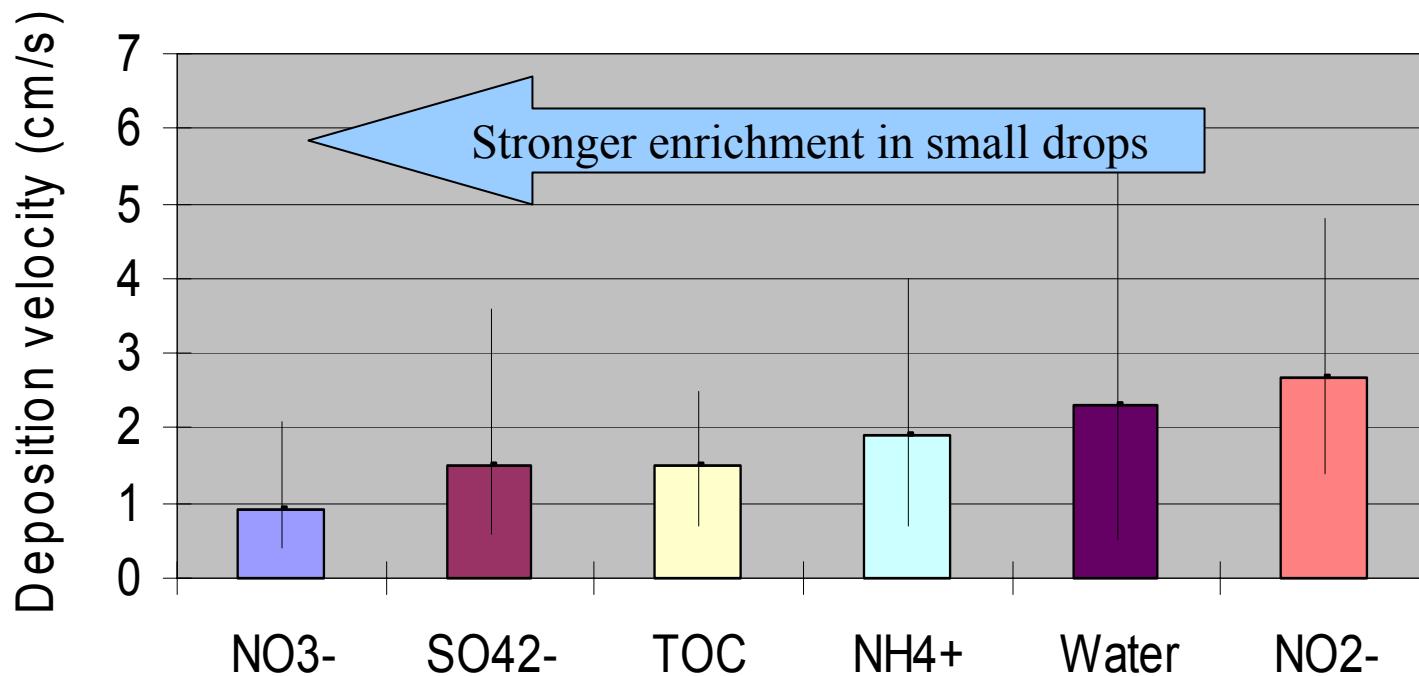
# Drop size dependence

- Most species enriched in small drops
  - $\text{NO}_2^-$  is an exception
- Can impact
  - Deposition
  - Aqueous chemistry



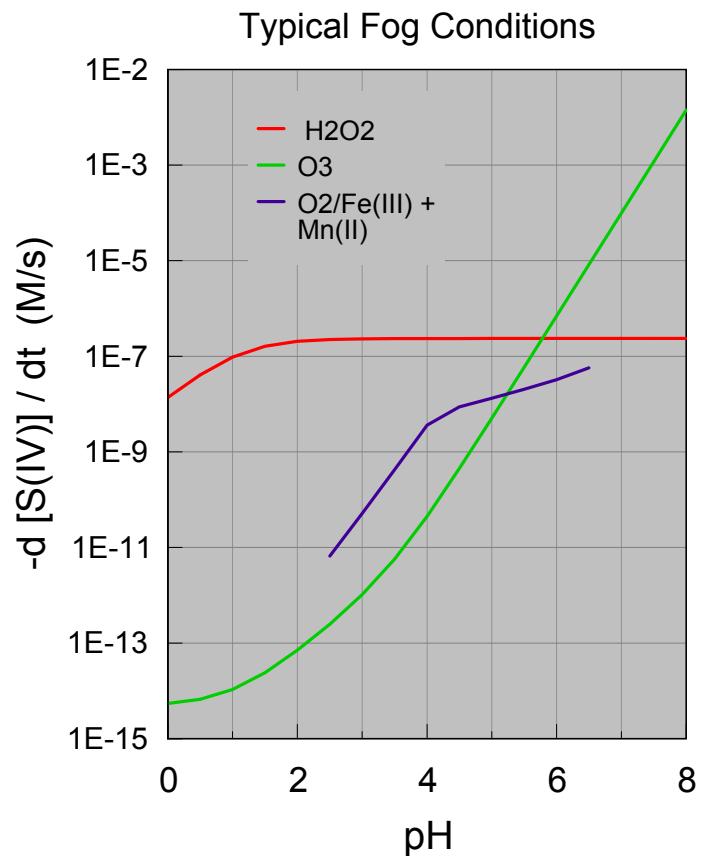
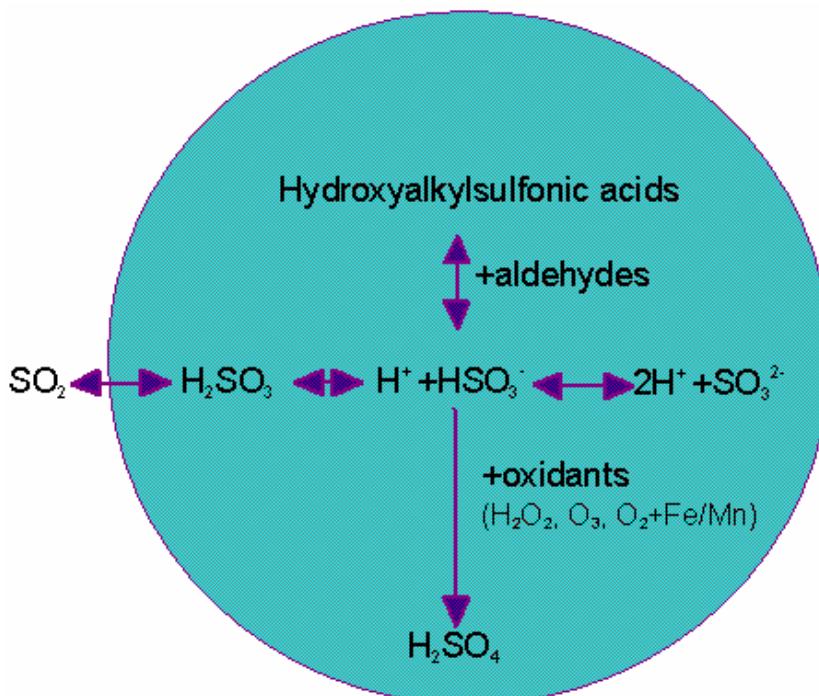
# Fog Deposition

- Deposition velocity,  $V_d = \text{Flux}/C$
- Much faster than dry deposition
- Removal  $\sim 1 \mu\text{g}/\text{m}^3 \cdot \text{hr}$



# New PM production

- High pH promotes rapid rxn. of dissolved  $\text{SO}_2$  to
  - sulfate
  - hydroxymethanesulfonate



# Summary

- Fogs interact strongly with aerosol particles and soluble trace gases
  - Nitrogen dominated
  - 100s of organic species
  - Distributed between solution and insoluble fraction
- Main effect of fogs on PM is scavenging and removal
  - Can reduce airborne concentration by  $>1 \mu\text{g}/\text{m}^3\cdot\text{hr}$
  - Dep velocities depend on solute distribution across drop size spectrum
  - SOA production?

# Acknowledgements

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  - S. Pandis
- Funding
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  - San Joaquin Valleywide Air Pollution Study Agency

# CRPAQS Fog Deposition

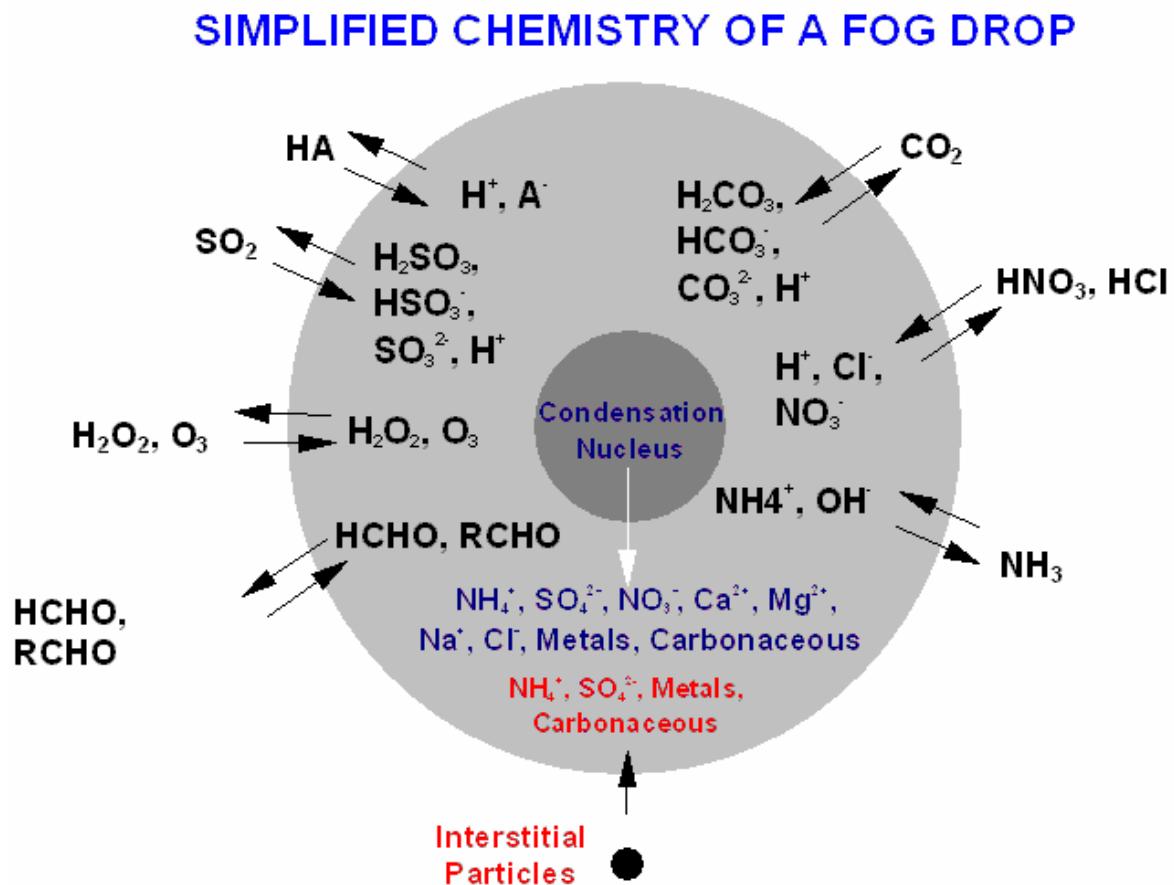
- Fog event fluxes range from 10s to 1000s of  $\mu\text{g}/\text{m}^2$
- Assuming a 100 m deep fog, concentrations would decrease typically
  - ~ 0.5  $\mu\text{g}/\text{m}^3/\text{hr}$  sulfate
  - ~ 1  $\mu\text{g}/\text{m}^3/\text{hr}$  nitrate
  - ~ 1  $\mu\text{g}/\text{m}^3/\text{hr}$  ammonium
  - ~ 0.7  $\mu\text{gC}/\text{m}^3/\text{hr}$  TOC
- Remember, fog solutes can be volatile or non-volatile

Fog deposition

Sample Start Date	Sample Time (hour)	$\text{NO}_3^-$ ( $\mu\text{g}/\text{m}^2$ )	$\text{SO}_4^{2-}$ ( $\mu\text{g}/\text{m}^2$ )	$\text{NH}_4^+$ ( $\mu\text{g}/\text{m}^2$ )	TOC ( $\mu\text{gC}/\text{m}^2$ )
12/18/00	9.0	2246	1223	2627	952
12/19/00	2.3	127	50	203	72
1/15/01	2.0	51	22	71	75
1/17/01	7.8	393	174	526	309
1/21/01	3.0	774	173	448	312
1/25/01	2.5	37	26	70	66
1/31/01	3.8	592	251	463	452
2/1/01	1.7	96	71	101	113

# Particle and gas scavenging

- Particles scavenged by nucleation, diffusion, impaction, interception
- Soluble gases partition to drop



# CMU Modeling (Fahey and Pandis)

- Fog model reasonably predicts
  - Bulk fog composition
  - Size-dependence
  - Deposition fluxes

